

BAKERSFIELD'S RED LIGHT PHOTO ENFORCEMENT SYSTEM:
AN ANALYSIS OF COST-EFFECTIVE ALTERNATIVES

By

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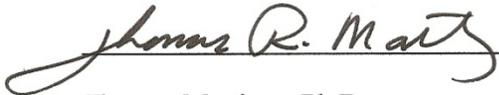
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EXECUTIVE SUMMARY

In 2003, the red light photo enforcement system was implemented in Bakersfield under the supervision of the Bakersfield Police Department, thereby enacting a system to deter red light running and the subsequent intersection collisions. Although the system has been able to deter collisions related to red light running at the eight various intersections in Bakersfield, the cost-effectiveness of the system is in question.

The Red Light Photo Enforcement system is intended to deter red light running, reduce right-angle crashes (T-bone crashes), and increase protection of innocent passengers and pedestrians; however, taking into consideration the high cost of the Redflex photo enforcement system, the insufficient net revenue amount, and the increased costs of future additions, the City of Bakersfield would benefit the most from a more cost-effective traffic collision mitigation system.

The purpose of this policy analysis is to examine two policy alternatives to Bakersfield's existing red light photo enforcement system and determine which one (or more) could best provide an effective intersection collision mitigation system at the lowest cost. This policy analysis analyzes the following two alternatives: (1) increase the yellow-light interval and (2) increase the all-red clearance interval. Choosing the best alternative(s) will have a significant impact on the City of Bakersfield by implementing a more cost-effective way to reduce red light running and intersection collisions; in turn, providing additional monies to be used in critical areas of the Bakersfield Police Department.

The recommendation of this policy analysis is to increase the yellow-light interval as well as the all-red clearance interval and to discontinue Bakersfield's red light photo enforcement system. It is recommended that both the yellow-light interval and the all-red

clearance interval be increased by one second. The process of choosing the best alternative(s) and cost-effective strategy is based on making sure the final selection(s) meet the criteria of efficiency, reliability, feasibility, and effectiveness.

CHAPTER 1 – INTRODUCTION

Background of the Problem

Redflex cameras are responsible for capturing photo and video evidence of drivers in violation, not only to enforce the law against running red lights, but to decrease the amount of intersection collisions caused by violators. According to Redflex Traffic Systems (2014), “When the radar detects a vehicle running a red light, the camera system is activated to record the violation which includes a close-up image of the license plate.” If the intersection is equipped with multiple photo enforcement approaches, the drivers photograph will also be taken. Those in violation of the law at intersections equipped with Redflex photo enforcement technology will be issued a minimum fine of nearly \$490 for each infraction (Governor’s Highway Safety Association, 2014). According to Redflex Traffic Systems (2014), the benefits of the program’s implementation include increased transparency, decreased red light running, reduced right-angle crashes (T-bone crashes), and increased protection of innocent passengers and pedestrians. Additionally, according to the Governor’s Highway Safety Association (2014), in order to maximize safety benefits, jurisdictions should use enforcement cameras appropriately and effectively, thereby supporting the following four principles:

1. Cameras should be used at high crash sites or in situations where traffic law enforcement personnel cannot be deployed safely. There should be a traffic engineering analysis of each site before traffic cameras are installed and citations issued.
2. Cameras are not to replace traditional law enforcement personnel or to mitigate safety problems caused by deficient road design, construction or maintenance.
3. Use of cameras should be preceded by a public information campaign. The campaign should continue throughout the life of the automated enforcement program.

4. Cameras should not be used as a revenue generator. Compensation paid for an automated traffic law system should be based on its value and not on the amount of revenue it generates nor the number of tickets issued. Revenues derived from the automated enforcement program should be used solely to fund highway safety functions. (Governor's Highway Safety Association, 2014, p. 24)

In March 2003, the Bakersfield Police Department implemented the red light photo enforcement system under the direction of the Operations Division and Traffic Enforcement subdivision (Superior Court of California, 2014). The photo enforcement system's goal is to prevent red light running; in turn, preventing intersection collisions (serious and non-serious). To carry out the department goals in terms of traffic enforcement, the Bakersfield Police Department has contracted with Redflex Traffic Systems Inc. on five-year bases—with the option of two, one-year extensions. Redflex Traffic Systems Inc. is the provider of the photo enforcement technology, known as REDFLEXred, and is responsible for the construction and maintenance of the photo enforcement systems at various intersections across Bakersfield. The city determined which intersections had the highest traffic and collision rates and at this time a total of eight intersections are equipped with photo enforcement technology—Bernard/Oswell, Chester/Brundage, Coffee/Truxtun, Ming/Real, Ming/Valley Plaza, California/Oak, California/New Stine, and White/Wible (Bakersfield City Council, 2008). Among the eight intersections, twelve red light cameras are in place. This means that certain intersections are equipped with multiple angle technology, or in other words, multiple approaches. At this time, the eight existing intersections are the only ones under contract, but the Bakersfield Police Department has expressed considerations for future expansion to include photo enforcement at the following intersections: Ashe/White, Gosford/White, Buena Vista/Stockdale,

Gosford/Stockdale, Gosford/Ming, 24th/M, Coffee/Rosedale, Hageman/Calloway, Stockdale/Allen, and 24th/F (Bakersfield City Council, 2008).

Photo Enforcement Costs

Since the initial contract in 2003, the California Vehicle Code [VC 21455.5 (g)] was amended to prohibit payments based on the number of citations generated (Bakersfield City Council, 2008). As a result, in 2008, the City of Bakersfield established a billing amendment that included a flat-fee of \$1000/month per approach for the four approaches with the lowest citation history and a flat-fee of \$4,200/month per approach for the eight remaining approaches (Bakersfield City Council, 2008). After implementation of the flat-fee amendment, the monthly fixed payment for the twelve existing approaches amounts to \$37,600. To cover this monthly cost, the Bakersfield Police Department is allotted \$500,000 from the Traffic Safety Fund (See Appendix B). In addition to covering the flat-fee monthly expenses (\$37,600), the Traffic Safety Fund also covers the utility costs for the twelve red light cameras (Barrios, 2013).

According to the Bakersfield City Council (2008), it can be inferred from previous citation rates that the expected net revenue for City of Bakersfield as a result of red light violations amounts to \$33,730/year. The revenue amount can fluctuate higher or lower depending on the number of citations issued and violators actually paying off those citations, but will not change dramatically. Previously and currently, this revenue amount is incapable of funding even just one month of the red light photo enforcement system's cost. Moreover, the Bakersfield Police Department relies heavily on the funding allotted from the Traffic Safety Fund to cover all expenses incurred by the red light photo enforcement system.

In addition to the twelve existing approaches disbursed amongst the eight intersections, Redflex has offered the opportunity for the city to add future approaches at a flat-fee of

\$6,070/month per approach (Bakersfield City Council, 2008). Redflex will allow additional intersections and approaches to be constructed, but has limited future additions to ten intersections and twenty approaches in the current contract.

Statement of the Problem

Due to the high cost of operating, managing, and maintaining Bakersfield's red light photo enforcement system and the lack of optimum results, the current system does not prove to be cost-effective. While the red light cameras have proven to deter red light running; in turn, decreasing broadside collisions for the most part, unintended results have occurred as well. The unintended consequences are counteractive to the system's beneficial results.

Although the Reflex Photo Enforcement system is used to generate financial benefits in terms of fewer serious (broadside) crashes, less property damage, reduced automobile insurance rates, decreased emergency services demand, and most importantly fewer injuries and deaths, none of these financial benefits actually translate into money that enables the system to be self-sustaining. The City of Bakersfield only generates approximately \$33,730 in net revenue per year, which is not nearly enough to make up the \$500,000 expenditure funded by taxpayer dollars.

Furthermore, the Bakersfield Police Department has considered future expansion at ten additional intersections. At a rate of \$6,070/month per approach—\$1,800 more than existing expenses per approach—concerns arise regarding the significantly increased costs that will result. Procuring additional funding ranging from approximately \$60,700/month to \$121,400/month, to fund a system that does not produce optimum results in the first place may be inappropriate and does not prove to be as beneficial to the City of Bakersfield as previously thought.

Methods and Procedures of the Study

To conduct this policy analysis, the researcher collected and analyzed data to compare the cost-effectiveness of the status quo against the potential alternatives. The tasks the researcher must perform to choose the most cost-effective alternative to Bakersfield's existing red light photo enforcement system includes an in-depth research and analysis of periodicals, journals, and other related publications.

Importance of the Study

The Bakersfield Police Department's overall responsibility is to, "Provide public safety and effective law enforcement to the City of Bakersfield" (City Manager's Office, 2013). In attaining that goal the department has established divisions and subdivisions to specialize in strategic ways to achieve that objective. More specifically, the Traffic Enforcement subdivision's responsibility is to, "...provide for the safe and orderly flow of traffic" (City Manager's Office, 2013). In order for the Bakersfield Police Department to adequately provide a safe and orderly flow of traffic, the department must have the most cost-effective resources and strategies implemented in order for the public to get the most benefit. In response to high intersection collision rates (serious and non-serious), the Bakersfield Police Department has implemented the red light photo enforcement system in order to decrease those numbers. However, in doing so, the City of Bakersfield has actually implemented a system that is not cost-effective; in turn, spawning the need to evaluate possible alternatives to employ in order to create an effective method to mitigate intersection crashes caused by red light running, whilst being cost-effective.

Taking into consideration the high cost of the Redflex photo enforcement system, the insufficient revenue amount, and the increased costs for future additions, the City of Bakersfield

would benefit the most from a more cost-effective traffic collision mitigation system. Additionally, Bakersfield may also be benefited by a more cost-effective system given that the funding provided to the red light photo enforcement system could be utilized in more vital areas of the Bakersfield Police Department.

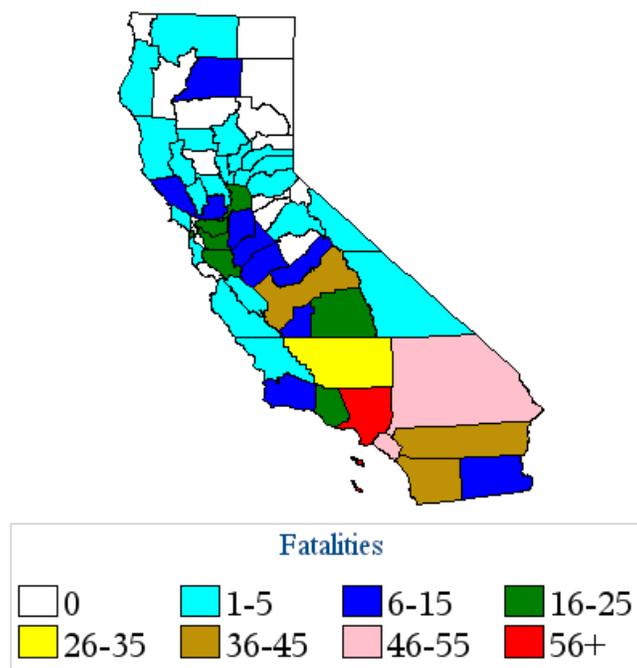
CHAPTER 2 – LITERATURE REVIEW

Problem Definition

The onset and execution of the red light camera systems across the United States was influenced by the high and increasing death rates related to serious intersection collisions that were a result of red light running. Studies dating back to the 1990's demonstrate that red-light running at intersections was at an all-time high as well as steadily increasing (Insurance Institute for Highway Safety, 1998). More recent rates of fatal intersection collisions substantiate the ongoing need for a mitigation method for red light running and the resulting intersection collisions. According to the National Highway Traffic Safety Administration (2012), Kern County's fatality rate in crashes involving an intersection totaled 31 in 2008, 27 in 2009, 34 in 2010, 26 in 2011, and 33 in 2012 (See Appendix C).

Figure 1. Fatalities in Crashes Involving an Intersection (California)

Fatalities in Crashes Involving an Intersection (or Intersection Related)



*National Highway Traffic Safety Administration, 2012

Furthermore, the closely related, but variant pattern of higher and lower fatality rates over the five-year span indicates that there is a need for improvement and implementation of additional and/or different measures of intersection collision mitigation. A mitigation method that would decrease the rate of fatal, as well as non-fatal, intersection crashes indefinitely plays an essential role in achieving a cost-effective system.

Program Effectiveness

According to the Bakersfield City Council (2008), broadside collisions decreased at photo enforced intersections whereas rear-end collisions increased. The Table 1 below shows that broadside collisions decreased by 89 or 38 percent, with one exception (Coffee/Truxtun). However, rear-end collisions increased by 30 or 8 percent and only half of the intersections showed a decrease. While rear-end collisions are considered non-serious and normally do not result in significant vehicle damage, intersection collisions have still increased which defeats the purpose of the system.

Table 1. History of Rear-end and Broadside Collisions at the Photo Enforced Intersections

INTERSECTION	# MONTHS ON-LINE	REAR -END			BROADSIDE		
		PRE	POST	%Δ	PRE	POST	%Δ
Bernard/Oswell	50	9	16	78%	23	12	-48%
Chester/Brundage	50	49	24	-51%	37	9	-76%
Coffee/Truxtun	48	56	121	116%	33	36	9%
Ming/Real	36	87	78	-10%	34	19	-44%
Ming/Valley Plaza	36	20	12	-40%	27	25	-7%
California/Oak	28	52	61	17%	27	18	-33%
California/New Stine	24	41	68	66%	15	12	-20%
White/Wible	20	66	30	-55%	37	13	-65%
TOTALS		380	410	8%	233	144	-38%

*Bakersfield City Council, January 2008

Revenue, Funding, & Future Costs

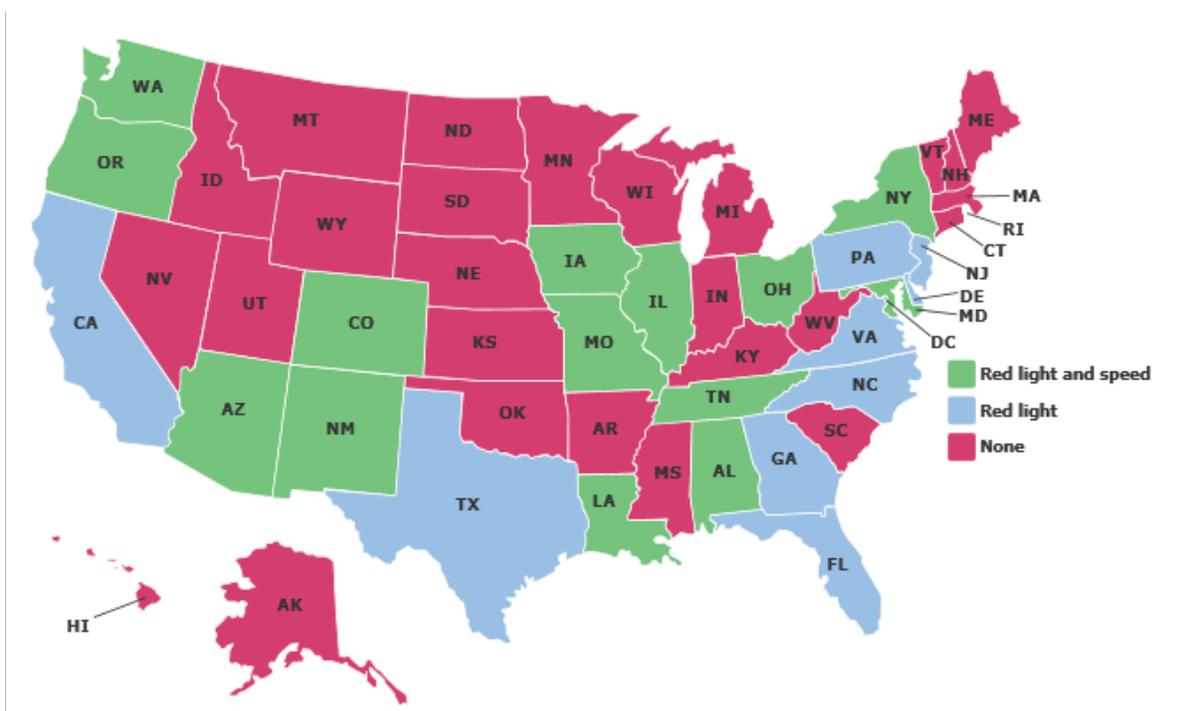
The cost-effectiveness of red light photo enforcement is dependent on the system's ability to produce positive results (reduction in fatal and non-fatal intersection collisions) at the lowest cost. Currently, Bakersfield's photo enforcement costs amounts to a fixed monthly rate of \$37,600 to operate eight intersections with twelve approaches which leads to the yearly net revenue of approximately \$33,730/year (Bakersfield City Council, 2008). At this time, the revenue amounts that Bakersfield receives on a yearly basis are not nearly enough to make up the cost incurred through the system's use; thus, the Traffic Safety Fund provides approximately \$500,000 per Fiscal Year to support its operation and utility costs.

However, in the coming years, the City of Bakersfield has plans to implement a photo enforcement system at ten additional intersection locations with each approach costing a fixed monthly rate of \$6,070—approximately \$1,800 more than existing rates per approach (Bakersfield City Council, 2008). Moreover, each of the ten intersections is capable of being equipped with two approaches. This means that the future additional costs can range from \$60,700/month to \$121,400/ month; thus, the system's cost could potentially amount to \$621,400/year.

National Issues

According to the Governor's Highway Safety Association (2014), 24 states, the District of Columbia and the U.S. Virgin Islands have red light cameras currently operating at, at least one location within the state. Additionally, among the 24 states, 506 communities are currently operating red light cameras (Insurance Institute for Highway Safety, 2014).

Figure 2. State Red light and/or Speed Camera Use



*Governor's Highway Safety Association, March 2014

Increasingly, states have found issues with the red light cameras. One of the more common problems associated with red light cameras that pertains to Bakersfield's situation is the resulting secondary (rear-end) collision increases. In most cases, red light cameras are responsible for decreasing the number of serious (broadside) intersection collisions; however, red light cameras may also be responsible for increasing secondary (rear-end) collisions at the same time. In a multijurisdictional study representing various locations in the United States, it was concluded that after the implementation of red light cameras, there was a decrease of 379 broadside collisions and 55 definite injuries resulting from those crashes (Griffith, 2005). The study also concluded that there was an increase of 375 rear-end collisions and 32 definite injuries resulting from those crashes (Griffith, 2005). These results indicate that red light cameras mitigate one issue (broadside collisions) at the same time as creating another (rear-end collisions).

Table 2. Combined Collision Results for Seven Jurisdictions in the U.S.

Table 1. Combined results for seven jurisdictions				
	Right-angle crashes		Rear end crashes	
	Total crashes	Definite injury	Total crashes	Definite injury
EB estimate of crashes expected in the after period without RLC	1,542	351	2,521	131
Count of crashes observed in the after period	1,163	296	2,896	163
Estimate of percentage change (standard error)	- 24.6 (2.9)	- 15.7 (5.9)	14.9 (3.0)	24.0 (11.6)
Estimate of the change in crash frequency	- 379	- 55	375	32

*Federal Highway Administration, April 2005

The controversy surrounding red light cameras is exemplified through recent state debates concerning the removal or continuance of the system. States such as Arizona, Colorado, Florida, Iowa, Idaho, and New Jersey have been debating on whether to keep the red light cameras or remove them altogether (Teigen, 2013). At this time there are a total of 9 states that prohibit the use of red light cameras—Arkansas, Maine, Mississippi, Montana, New Hampshire, South Carolina, Utah, West Virginia, and Wisconsin (Governor’s Highway Safety Association, 2014).

Although the problems associated with the system in various states and communities may differ from the specific issue that Bakersfield is currently facing (cost-effectiveness), they have responded to these problems in ways that may also serve as examples for the City of Bakersfield when trying to determine the most cost-effective strategy to reduce intersection collisions caused by red light running.

California Similarities

Examples that are closely related to Bakersfield's current situation are two California cities—Loma Linda and Los Angeles—that made the decision to prohibit and subsequently remove the existing Red Light Traffic Enforcement system. Los Angeles actually followed suit after the smaller city of Loma Linda experienced positive results subsequent to the removal of the city's red light cameras and implementation of low-cost changes to signal lengths. According to Bloomekatz (2011), some studies indicate that there are potential safety benefits of extending the length of yellow lights and other signal times at busy intersections. Furthermore, Bloomekatz asserts that another benefit to changing signal times is that it can be done at a low-cost in addition to decreasing the amount of disapproval caused by enforcing costly fines for less serious right-turn violations.

Major Stakeholders

State and Local Officials

State and local officials are responsible for and have the authority to decide whether or how to implement or reform the red light photo enforcement systems at the state, county, and local levels. These officials are accountable for the initial decisions concerning the photo enforcement system and begin the starting phases of the process of implementation as well as the continuous supervision of the system overtime. State and local officials also serve as a medium in the ongoing decision-making relative to the red light camera system and directly communicate with the contracted provider of the machinery.

Judges and Practitioners

These men and women are those that engage in litigation as a result of the red light cameras. Motorists in violation of red light running at the designated intersections may be in

contact with judges and those in similar professions depending on their specific circumstance. These men and women preside on the specific case in question and make decisions accordingly.

Motorists

Motorists, more specifically those in violation of the red light running law, are subject to red light photo enforcement and the associated traffic laws as well as the consequences of violation. Every motorist has the opportunity to come in contact with one of the various red light photo enforcement camera systems at the designated intersections. No matter the individual, each motorist is responsible for abiding by traffic laws, but especially those regarding red light running. Each motorist is and will remain under equal enforcement.

Passengers and Pedestrians

Passengers and pedestrians are often overlooked when red light photo enforcement is discussed. However, innocent passengers and pedestrians are often subject to intersection collisions, both serious and non-serious, to no fault of their own. These men, women, and children are in as much possible danger as motorists, if not more.

Bakersfield Police Department—Traffic Enforcement Division

At this time, Bakersfield's red light photo enforcement system is managed and implemented under the supervision and budget of the Bakersfield Police Department's Traffic Enforcement subdivision. The Bakersfield Police Department's Traffic Enforcement subdivision's responsibility is to, "...provide for the safe and orderly flow of traffic" (City Manager's Office, 2013). To provide the safe and orderly from of traffic, the Traffic Enforcements subdivision enforces and implements the red light camera system to aid in reducing intersection collisions related to red light running.

Goals and Objectives

This policy analysis will analyze alternatives to Bakersfield's existing red light photo enforcement system in order to attain cost-effectiveness and ongoing sustainability, then, recommend the best strategy or strategies to enforce under the Bakersfield Police Department's Traffic Enforcement subdivision. The chosen method(s) will contribute to the overall goal of decreasing intersection collisions caused by red light running, whilst attaining the lowest the cost(s) to enforce the appropriate safety measures.

Measures of Effectiveness

This study will identify measures to determine if alternative methods are more appropriate to attain a cost-effective and sustainable intersection collision mitigation system as opposed to the status quo. In order to identify the best alternative(s) to Bakersfield's existing photo enforcement system, a set of criteria that can be universally shared among all stakeholders will be used to select each potential option as follows:

- **Efficiency.** The chosen method must provide the greatest output at the least cost.
- **Reliability.** The chosen method must be a dependable source that objectively enforces red light regulations effectively and efficiently in order to maintain the safest intersections.
- **Feasibility.** Ease of implementation and acceptability among all stakeholders should be high and/or increased. Moreover, current and future citizen support and/or opposition (politics) along with the time-frame of integration will be taken into consideration when assessing an alternative's feasibility.

- **Effectiveness.** The chosen method must provide the best possible amount of safety to ensure that motorists, passengers, and pedestrians acquire optimal results from the system in comparison to the cost(s).

Potential Solutions

Bakersfield's existing photo enforcement system seems to be beneficial in several aspects of its operation, such as decreasing the number of fatal intersection collisions, decreasing the frequency of red light running, and serving as an alternative to police officers when the department is low on funding. However, it may not be the most cost-effective method, given that costs are high while revenue amounts are so low that the system is not capable of being self-sustaining for just one month of operation and rear-end collisions have increased. Therefore, the following are potential alternatives to the existing system: (1) increase the yellow-light interval and (2) increase the all-red clearance interval. Chapter 3 will discuss each potential solution in greater detail with focus on the comparison of future consequences, spillovers and externalities, and constraints and political feasibility.

CHAPTER 3 – POLICY ANALYSIS

Due to California's lack of policy to prohibit or remove red light cameras, alternatives to Bakersfield's existing red light photo enforcement system are limited. This policy analysis offers a few recommendations that present more cost-effective methods to mitigating red light running which may result in intersection collisions. These potential solutions can be implemented under the Bakersfield Police Department's supervision. The two specified alternatives (in addition to the status quo) are considered engineering countermeasures to red light running. The measures used to decrease red-light running and subsequent serious collisions include: increasing the yellow-light time interval and adding or increasing the all-red clearance interval. These alternatives will be evaluated and compared based on efficiency, reliability, feasibility, and effectiveness.

Status Quo

One option is to keep the current system as is, meaning that the City of Bakersfield will continue to use the Redflex photo enforcement system as a mitigation method for red light running and the subsequent intersection collisions. The system will detect those in violation of red light regulations and issue the motorist(s) a ticket of no less than \$490 for each infraction. The system is intended to deter motorists from making red light violations; in turn, decreasing the number of intersection collisions.

The current contract outlines that the operation costs include a flat-fee monthly payment to Redflex of \$37,600 for the eight existing intersections and twelve approaches. The totaled monthly flat-fees amount to \$451,200/year or roughly 90 percent of the \$500,000 in funding allotted from the Traffic Safety Fund. Moreover, the additional allotment (\$48,800) covers the City's utilities costs incurred through the system's daily operation. The revenue amount that the

City collects is dependent on the number of citations issued and how many of those citations are actually paid. Past yearly net revenue totals are significantly low—so low that the amount will not cover just one month of operation costs—which indicates that the system is not self-sustaining and will continue to rely solely on the Traffic Safety Fund to cover all the system's costs.

Comparison of Future Consequences

Bakersfield is nearing the end of the Redflex contract and will have to decide whether to continue the services or choose other options for mitigating red light running and intersection collisions. If the City decides to keep the current system in place, the expected future expansion ideas will also remain intact. Expanding the current system could possibly generate more revenue upon implementation, but as motorists adapt to the red light cameras at the newly designated intersections, citation rates and payments will soon decrease just as the existing system has experienced. This would mean that a dramatic increase in taxpayer funding would occur only to support a system that produces similar benefits to the existing one; thus, taxpayer money (Traffic Safety Funds) would not be used effectively

Spillovers and Externalities

Since its implementation in 2003, Bakersfield's red light photo enforcement system has managed to decrease the total number of broadside collisions between the eight intersections currently operating red light cameras. However, according to the Bakersfield City Council (2008), rear-end collisions have increased by 8 percent. Moreover, according to the Transportation Research Board (2003), Bakersfield has experienced a slight spillover effect. Following the implementation of red light cameras, Bakersfield saw a slight decrease in crashes and related injuries at non-signalized intersections. In a study conducted by the Transportation

Research Board (2003), over a period of nearly 2.5 years, non-signalized intersections experienced a decrease of seven total crashes and a decrease of four injury crashes at those intersections (See Appendix D). Although these numbers are minimal given the time-frame, the data indicates that spillover has occurred.

Constraints and Political Feasibility

At this time, the City of Bakersfield is only generating approximately \$33,730/year in revenue from the red light cameras which means that there's a heavy reliance on taxpayer funding; in other words, monies allotted from the Traffic Safety Fund. Bakersfield's current system is not self-sustaining and with plans to expand photo enforcement in the future, the City may find it hard to secure additional funding as it would be costly—ranging from \$60,700/month to \$121,400/month. Although the expansion would increase the number of citations issued; in turn, increasing revenue, it may still not be enough to cover monthly costs to operate the system as monthly expenditures would increase greatly. Also, the money required to expand the system compared to low revenue amounts and benefits, may not be a popular agenda for the City of Bakersfield at this time.

Alternative #1: Increase the Yellow-Light Interval

The first alternative to implement in place of the existing system is to increase the yellow-light interval by one second. According to the U.S. Department of Transportation (2005), “the purpose of the yellow interval is to warn approaching traffic of the imminent change in the assignment of right-of-way.” The minimum length of the yellow-light interval is determined by set standards that allocate enough time for a vehicle to pass through the intersection at its present speed before the traffic signal turns red or to allow a driver to stop at a comfortable deceleration speed before entering the intersection (See Appendix E). According to

the Federal Highway Administration (n.d.), a properly timed yellow-light interval is essential to reduce red light violations.

Comparison of Future Consequences

This alternative would be a cost-effective approach to mitigating red light running and intersection collisions as it would not require significant costs or additional funding. However, this alternative is not as crucial in deterring motorists from running red lights; but even so, it uses safety measures and precautions as a way to produce the same or greater effects. Adding one second to the yellow-light interval would not disturb the intersection's organization because one small modification would have to be made.

Spillovers and Externalities

The U.S. Department of Transportation asserts that lengthening the yellow-light interval, within appropriate guidelines, has proven to significantly reduce the rate of unintended red light running. In a study conducted by Bonneson and Zimmerman (2003), it was concluded that generally an increase in the yellow-light interval by 0.5 to 1.5 seconds will decrease the frequency of red-light running by 50 percent. However, in the same study it was concluded that there would be a more modest effect on collisions related to red light violations. Furthermore, motorists may adapt to the longer yellow-light interval and begin entering the intersection later, which can cause a slight increase in red-light violations after the initial reduction.

Constraints and Political Feasibility

According to the Federal Highway Administration, the Manual on Uniform Traffic Control Devices (MUTCD) provides guidance that a yellow-light interval should have a duration of approximately 3 to 6 seconds, with the longer intervals reserved for use on approaches with higher speeds. Adding just one second to the existing yellow-light interval would fall within the

guidelines; however, decision-makers may be reluctant to alter the existing interval times due to possible synchronization issues.

Alternative #2: Increase the All-Red Clearance Interval

Another alternative to the red light photo enforcement is to increase the all-red clearance interval by one second. According to the U.S. Department of Transportation (2005), an all-red clearance interval provides additional time for motorists that are currently in the intersection to safely pass through on the red signal at the same time as holding cross traffic on the cross street approaches. The red clearance interval's purpose is not to reduce the rate of red light running; rather it is a safety measure.

Comparison of Future Consequences

While the all-red interval is only a safety measure, its intended purpose is still beneficial to intersections with high collision rates and has the potential to reduce collisions even if that's not the purpose of its creation. There is opportunity to expand the all-red interval by approximately three seconds at any given location, given that the existing all-red interval normally ranges from one to three seconds. Despite the potential to expand the all-red interval by three seconds or more seconds depending on location, it is recommended that Bakersfield's all-red clearance interval be extended by only one second in order to maintain orderly and synchronized intersections. Adding one second to the all-red clearance interval would not dramatically disturb an intersection's daily operation and serves as a cost-effective measure to help mitigate intersection collisions.

Spillovers and Externalities

According to Souleyrette, O'Brien, and McDonald (2004), most studies have reported safety benefits from the addition of the all-red clearance interval, but a few other studies have

produced mixed results. Mixed results refer to some intersections having beneficial results and other intersections are stagnant in producing a clear outcome—positive or negative. According to the Federal Highway Administration (n.d.), other studies show that when used in collaboration with other countermeasures, the all-red clearance interval has the potential to significantly decrease serious collisions. One drawback of implementing a longer all-red clearance interval involves a decrease in capacity at intersections due to the longer wait time for motorists, but this usually only affects small or already congested intersections. Increasing intersection safety is a component of decreasing serious injury collisions caused by red light running; thus, implementing an all-red clearance interval is still a low-cost safety measure and possible alternative to red light cameras.

Constraints and Political Feasibility

Similar to the yellow-light interval, the MUTCD indicates that the length of the all-red interval should be a function of traffic speed, cross street width, and length of the yellow interval which means that this alternative must be regulated and follow strict guidelines before implementation—another protective measure (Federal Highway Administration, n.d.). The MUTCD guidelines ascertain that the all-red clearance interval should not exceed six seconds in length. Typically where implemented, the length of an all-red interval only ranges from one second up to no more than three seconds despite its six-second potential. Due to these strict guidelines, decision-makers may have a problem with manipulating the time interval as it may disturb the synchronization of the intersection(s) if not calculated appropriately. However, disturbing the synchronization of the designated intersection is not likely with a minimal one-second change to the clearance interval.

Each of the potential alternatives described above, including the status quo, are reasonable solutions used to mitigate red-light running as well as serious and non-serious intersection collisions. However, choosing the most cost-effective alternative is crucial in implementing a solution that produces the greatest results at the lowest cost. Chapter Four will discuss the criteria used to analyze the alternatives and determine the preferred alternative based on the criteria. In addition to examining the alternatives, Chapter Four will outline an implementation strategy and include provisions for monitoring and evaluating the progress of the preferred solution.

CHAPTER 4 – ALTERNATIVE SELECTION

Criteria for Recommending Alternatives

The potential alternatives to Bakersfield’s red light photo enforcement system can best be measured based on effectiveness and efficiency. Each alternative (including the status quo) will be measured and reviewed based on these criteria, which will assist in the determination of the most cost-effective alternative(s).

Effectiveness will be based on the alternative’s ability to enhance the safety of motorists, passengers, and pedestrians who use designated intersections with high traffic volumes and collision rates caused by red light violations. Enhancing safety constitutes an alternative’s ability to decrease red light violation percentages; in turn, decreasing intersection collision rates.

Efficiency will be based on the amount of money required to implement the alternative(s). Furthermore, it refers to the alternative’s ability to provide the appropriate course of treatment through the best use of resources (lowest cost). In other words, the cost of the alternative should be equivalent to the level of safety provided.

Evaluation of Alternatives

Status Quo

Effectiveness. Since 2003, Bakersfield’s red light photo enforcement system has been able to reduce the number of serious intersection collisions related to red light violations. Data provided by the Bakersfield City Council (2008) indicated that serious intersection collisions were decreased by 38 percent. However, the same data indicated that rear-end collisions increased by 8 percent. While an 8 percent increase may not be as significant as the decrease seen in broadside collisions, the former can not negate that the latter is still a significant

revelation. Securing taxpayer dollars to mitigate one problem only to cause another does not represent a cost-effective method to mitigating intersection collisions in Bakersfield.

Additionally, according to the Transportation Research Board (2003), a spillover effect may have occurred in which non-signalized intersections experienced a reduction of four collisions involving an injury over a period of roughly 2.5 years. However, this data is not significant enough to determine whether those numbers were a result of implementing signalized intersections.

Efficiency. In 2008, the City of Bakersfield entered into a five-year contract with Redflex which established that the City would be charged a flat-fee rate of \$37,600/month—totaling \$451,200/year—to operate and maintain the photo enforcement systems. Patterns showed that the normal, annual net revenue amount would be around \$33,730. This amount is very low compared to the high cost of the system. Seeing that other cities are capable of maintaining a self-sustaining system, it is clear that Bakersfield’s system is not producing the expected return. While photo enforcement is not and should not be used as a revenue source other than to provide monies to support the Traffic Safety Fund, generating a revenue amount that could sustain the system rather than solely relying on the support from \$500,000 in taxpayer dollars (Traffic Safety Fund) is a reasonable expectation. However, at this time Bakersfield continues to fund the red light photo enforcement system with only the taxpayer dollars provided to the Bakersfield Police Department through the Traffic Safety Fund.

Alternative #1: Increase the Yellow-Light Interval

Effectiveness. Data shows that increasing the yellow-light interval by one second can greatly reduce serious collisions at intersections. One study indicates that increasing the yellow-light interval by one second can reduce red light running by as much as 50 percent (Bonneson &

Zimmerman, 2003). A significant reduction in red light running can yield similar decreases to serious intersection collisions because red light violations are most often responsible for them.

Efficiency. The cost relative to increasing the yellow-light interval by one second is not significant in that implementing this method would require existing resources (traffic signals) and a change in technicalities (coding to cause an all-red clearance interval to occur). If any, the cost to implement the new yellow-light interval would be minimal.

Alternative #2: Increase the All-Red Clearance Interval

Effectiveness. While an all-red clearance interval is not a deterrence method, it serves as a safety measure which can ultimately decrease serious intersection collisions. Most studies have shown that increasing the all-red clearance interval is a beneficial measure; however some studies show that increasing the interval did not produce any results (Souleyrette et al., 2004). The Federal Highway Administration suggests that the all-red clearance interval yields the best results when used in collaboration with other measures.

Efficiency. Similar to the cost of the increased yellow-light interval, the cost relative to increasing the all-red clearance interval by one second is not significant. Implementing this method would require existing resources (traffic signals) and a change in technicalities (coding to cause an all-red clearance interval to occur). If any, the cost to implement the new all-red clearance interval would be minimal.

Preferred Alternative(s)

Given the high cost of Bakersfield's red light photo enforcement system and the less than optimal benefits, it is recommended that Bakersfield discontinues the contract with Redflex indefinitely. While data indicates that photo enforcement is responsible for the decrease in

serious intersection collisions, the increase in rear-end collisions, and the heavy reliance on taxpayer dollars, it is not cost-effective to continue operating the system.

It is recommended that Bakersfield implement a one-second increase to the yellow-light interval as well as a one-second increase to the all-red clearance interval to be employed in a collaborative effort in order to yield similar benefits to photo enforcement, but at significantly decreased cost.

Outline of Implementation Strategy

First, the Bakersfield City Council should notify the public of the expected changes. Following the public notice, the two alternatives should immediately be employed collectively at the eight intersections designated for photo enforcement, as these intersections possess the highest rates of intersection collisions (serious and non-serious) and could yield the most benefit. The Public Works Traffic Division would be responsible for coordinating and enforcing the increased yellow-light and all-red clearance intervals at the designated intersections.

Provisions for Monitoring and Evaluation

The Public Works Traffic Division will monitor the number of intersection collisions at all eight designated intersections following the implementation of the one-second increase to the yellow-light interval as well as the one-second increase to the all-red interval. The department should continue to monitor and keep track of collision rates indefinitely, as they already do. Because the Public Works Traffic Division already monitors collision rates across Bakersfield, it would not cause a burden or additional task for the department to perform. The new traffic collision mitigation method would be evaluated based on the results that it yields (intersection collision rates) in comparison to the results that the photo enforcement system produced.

However, the success or failure of the system should not be determined based solely on the comparison against photo enforcement, but should also be evaluated based on cost-effectiveness.

Limitations and Unanticipated Consequences

Following the removal of the red light photo enforcement cameras and the addition of a one-second increase to the yellow-light and all-red clearance intervals, the number of intersection collisions may be slightly skewed or underestimated due to the spillover effect from motorists' adaptation to the previous photo enforcement. However, as time goes by the number of intersection collisions may be reflected properly and may be slightly less than numbers produced by photo enforcement. Moreover, the number of rear-end collisions may be slightly skewed or overestimated due to the pressure to stop in order to avoid a costly fine, which is caused by the motorists' adaptation to the previous photo enforcement. Overtime, motorists will adapt to the new intersection mitigation collision method and results will exhibit more accurate calculations.

CHAPTER 5 – SUMMARY, CONCLUSION, AND GENERAL RECOMMENDATIONS

Summary

Since 2003, Redflex photo enforcement has been used in Bakersfield to deter red light violations and the subsequent intersection collisions at various intersections across the City that contains the highest volumes of traffic and rates of collision. Under the contract, Bakersfield has agreed to pay a flat-fee of \$37,600/month to Redflex which amounts to \$451,200/year. The Bakersfield Police Department has repeatedly procured roughly \$500,000/year from the Traffic Safety Fund to finance the system. However, the department is only acquiring approximately \$33,730 in net revenue per year to apply toward the system's expenses and/or traffic safety. Therefore, the current system is far from self-sustaining.

Despite the fact that the photo enforcement system has provided benefits to Bakersfield which are exemplified by the decrease in serious intersection collisions, data has indicated that an increase in rear-end collisions has occurred simultaneously. Notably, photo enforcement has mitigated one problem, but has caused another. Given the high cost to operate and maintain the system, an increase in rear-end crashes shows that the current system is not resulting in optimal intersection safety, which is the general goal of red light photo enforcement.

Conclusion

At this time, the Bakersfield Police Department is faced with the decision to renew the current contract with Redflex or discontinue the use of red light photo enforcement. This decision is critical, as data shows that the system is not cost-effective. However, if the contract is renewed, plans for future expansion will rollover. This would mean that the City of Bakersfield would be charged \$6,070/month per approach, or in other words, a minimum of \$60,700/month and a maximum of \$121,400/month in addition to the existing flat-fee of

\$37,600/month. At this time, it is not plausible to expand the system and incur additional costs, given that the current system is not producing the best results at the lowest cost(s).

Recommendations

Taking into account the high cost to enforce red light cameras, the insufficient revenue amounts, the mixed results pertaining to collision rates, and the significant increase for future additions, it is suggested that Bakersfield take a different course of action and discontinue red light photo enforcement. It is recommended that in place of the existing photo enforcement system, two alternatives be implemented collaboratively. The first alternative is to increase the yellow-light interval by one second at each of the intersections currently equipped with photo enforcement. The second alternative is to increase the all-red clearance interval by one second at those same intersections. These alternatives serve as low-cost countermeasures to reduce red light running and intersection collisions, and when used collaboratively results can be optimized.

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Appendix A

IRB Authorization Letter



CSU Bakersfield

Academic Affairs

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Department of Psychology
Research Ethics Review Coordinator
and IRB/HSR Secretary

Date: 20 May 2014

To: Kaylah Hill, PPA Student

cc: Jinping Sun, Department of Public Policy & Administration
Paul Newberry, IRB Chair

From: Steve Suter, Research Ethics Review Coordinator

Subject: Protocol 14-58: Not Human Subjects Research

Thank you for bringing your protocol, "**Bakersfield's Red Light Photo Enforcement System: An Analysis of Cost-Effective Alternatives**", to the attention of the IRB/HSR. On the form, "*Is My Project Human Subjects Research?*", received on May 27th, 2014, you indicated the following:

I want to interview, survey, systematically observe, or collect other data from human subjects, for example, students in the educational setting. **NO**

I want to access data about specific persons that have already been collected by others [such as test scores or demographic information]. Those data can be linked to specific persons [regardless of whether I will link data and persons in my research or reveal anyone's identities]. **NO**

Given this, your proposed project will not constitute human subjects research. Therefore, it does not fall within the purview of the CSUB IRB/HSR. Good luck with your project.

If you have any questions, or there are any changes that might bring these activities within the purview of the IRB/HSR, please notify me immediately at 654-2373. Thank you.

Steve Suter, University Research Ethics Review Coordinator

Appendix B

Bakersfield Police Department's Operations Division FY 14-15 Budget

OPERATIONS

EXPENDITURES:	Actual 2012-13	Adopted Budget 2013-14	Amended Budget 2013-14	Proposed Budget 2014-15
Personnel	\$ 36,456,030	\$ 40,264,397	\$ 41,398,855	\$ 42,192,275
Operating	5,093,110	5,583,033	5,583,033	5,538,385
Capital	30,284	-	-	-
Total	\$ 41,579,424	\$ 45,847,430	\$ 46,981,888	\$ 47,730,660
 SOURCE OF FUNDS:				
General Fund	\$ 39,484,020	\$ 45,236,250	\$ 46,324,708	\$ 47,184,660
Traffic Safety Fund	484,401	500,100	500,100	500,000
Supp Law Enforcement	189,901	40,580	86,580	46,000
ARRA Federal Stimulus Fund	1,421,102	70,500	70,500	-
Total	\$ 41,579,424	\$ 45,847,430	\$ 46,981,888	\$ 47,730,660

Appendix C

Fatalities in Crashes Involving an Intersection (California Counties)

County Name	Fatalities					Fatalities Per 100,000 Population				
	2008	2009	2010	2011	2012	2008	2009	2010	2011	2012
Alameda County	16	26	23	15	19	1.08	1.74	1.52	0.98	1.22
Alpine County	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Amador County	0	3	0	2	0	0.00	7.85	0.00	5.34	0.00
Butte County	4	1	10	4	3	1.83	0.46	4.55	1.82	1.35
Calaveras County	0	2	0	0	0	0.00	4.36	0.00	0.00	0.00
Colusa County	0	0	1	0	0	0.00	0.00	4.66	0.00	0.00
Contra Costa County	15	14	12	20	16	1.47	1.35	1.14	1.88	1.48
Del Norte County	1	0	0	0	0	3.51	0.00	0.00	0.00	0.00
El Dorado County	2	0	2	2	2	1.12	0.00	1.10	1.11	1.11
Fresno County	42	35	34	37	38	4.62	3.80	3.65	3.93	4.01
Glenn County	2	1	2	0	1	7.14	3.56	7.12	0.00	3.57
Humboldt County	1	1	1	4	5	0.75	0.75	0.74	2.96	3.71
Imperial County	8	11	6	4	11	4.76	6.40	3.44	2.27	6.22
Inyo County	3	1	0	0	1	16.38	5.39	0.00	0.00	5.41
Kern County	31	27	34	26	33	3.79	3.25	4.04	3.06	3.85
Kings County	10	9	9	1	8	6.58	5.91	5.91	0.66	5.29
Lake County	4	2	4	4	3	6.21	3.10	6.18	6.22	4.69
Lassen County	2	0	1	1	0	5.68	0.00	2.87	2.92	0.00
Los Angeles County	206	184	204	201	229	2.12	1.88	2.08	2.03	2.30
Madera County	6	6	6	0	8	4.04	4.02	3.97	0.00	5.26
Marin County	1	1	0	0	3	0.40	0.40	0.00	0.00	1.17
Mariposa County	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Mendocino County	2	2	3	2	2	2.29	2.28	3.42	2.29	2.29
Merced County	9	9	5	8	11	3.59	3.57	1.95	3.08	4.19

Appendix D

Crashes Before and After Enforcement (2003)

TABLE 8
CRASHES BEFORE AND AFTER ENFORCEMENT

City	Type of Intersection	Total Crashes			Injury Crashes		
		Before	After	Percent Change	Before	After	Percent Change
Bakersfield	Nonsignalized	760	753	-0.9	245	241	-1.6
	Signalized	771	739	-4.2	243	233	-4.1
San Bernardino	Nonsignalized	1,220	1,283	5.2	204	225	10.3
	Signalized	1,324	1,400	5.7	239	246	2.9
Santa Barbara	Nonsignalized	712	622	-12.6	113	115	1.8
	Signalized	488	438	-10.2	89	84	-5.6
Oxnard	Nonsignalized	994	1,011	1.7	173	194	12.1
	Signalized	1,322	1,250	-5.4	299	239	-20.1

[Source: Retting and Kyrychenko (14)].

Appendix E

Minimum Yellow-Light Interval

POSTED SPEED OR PRIMA FACIE SPEED		MINIMUM YELLOW INTERVAL
mph	km/hr	Seconds
25 or less	40 or less	3.0
30	48	3.2
35	56	3.6
40	64	3.9
45	72	4.3
50	80	4.7
55	89	5.0
60	97	5.4
65	105	5.8